M.Sc. in Mathematics

(Syllabus approved by Board of Studies meeting on 29.06.2017)

Department of Pure & Applied Mathematics

School of Mathematical and Computational Sciences

UNDER THE

CHOICE BASED CREDIT SYSTEM

SCHEME OF EXAMINATION

All papers of M.Sc. First and Second Semesters are compulsory. In M.Sc. Third and Fourth Semester **Two papers** are **core papers** and each student has to choose three among the given list of **optional papers (Including Project)**. A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Supervisor and topic of the dissertation for student will be allotted at the level of Department. The dissertation evaluation of 100 maks evaluated by a committee consisting of HOD, supervisor and external subject expert. Each paper (except project dissertation) is of 100 marks and its distribution is as under:

Internal Assessment : 40

End Semester Examination : 60

M.Sc. in Mathematics

Semester	Course code	Core Course	Credit Hours
I	MSC 1.1	Algebra - I	04
	MSC 1.2	Real Analysis	04
	MSC 1.3	Topology-I	04
	MSC 1.4	Differential Geometry - I	04
	MSC 1.5	Discrete Mathematical Structures	04
II	MSC 2.1	Algebra - II	04
	MSC 2.2	Complex Analysis	04
	MSC 2.3	Topology-II	04
	MSC 2.4	Differential Geometry - II	04
	MSC 2.5	Graph Theory	04
III (Core Group)	MSC 3.1	Functional Analysis	04
	MSC 3.2	Theory of Differential Equations –I	04
	MSO 3.1	Fuzzy Sets, Fuzzy Logic and their Applications –I	04
	MSO 3.2	Integral Equations	04

III (Optional Group ANY THREE)	MSO 3.3	Operations Research- I	04
	MSO 3.4	Differential Geometry of Manifolds	04
	MSO 3.5	Difference Equations –I	04
	MSO 3.6	Information Theory and its Applications	04
	MSO 3.7	Object Oriented Programming with C++	04
	MSO 3.8	Number Theory and Cryptography	04
IV (Core Group)	MSC 4.1	Advanced Functional Analysis	04
	MSC 4.2	Theory of Differential Equations –II	04
IV (Optional Group ANY THREE)	MSO 4.1	Fuzzy Sets, Fuzzy Logic and their Applications–II	04
	MSO 4.2	Finsler Geometry	04
	MSO 4.3	Operations Research- II	04
	MSO 4.4	Complex Manifolds	04
	MSO 4.5	Difference Equation –II	04
	MSO 4.6	Financial Mathematics and its Applications	04
	MSO 4.7	Project	04

MSC 1.1: Algebra - I

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Normal series - Normal and subnormal series, composition series, Jordan-Holder theorem, Solvable groups, Nilpotent groups.

Rings and Ideals - Maximal and prime ideals, Nilpotent and Nil ideals.

Modules- Definition and examples, sub modules, quotient modules, direct sums, modules generated by a subset, cyclic module, homomorphism of modules, isomorphism theorems, Exact sequence of modules, Simple modules, Semi-simple modules, Schur's lemma, Free modules.

Field Theory - Extension fields, Algebraic and transdental extensions, separable and inseparable extension, Normal extensions, Perfect fields, Finite Fields, Primitive Elements, Algebraically closed fields, Galois Extension, Fundamental theorem of Galois Theory.

Text Book:

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul Basic Abstract Algebra IInd Edition Cambridge University, Press Indian Edition.

Reference Books:

1. I.N. Herstein, Topics in Algebra Wiely Eastern Ltd. New Delhi (1975).
2. M. Artin, Algebra Prantice Hall of India 1991.
3. D.S. Malik, J.N. Mordeson & M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill International Edition 1997.

MSC 1.2: Real Analysis

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Definition and existence of Riemann-Stieltjes integral, Properties of the Integral, integration and differentiation, the fundamental theorem of Calculus, Integration of vector - valued functions. Rectifiable curves.

Lebesgue outer measure, Measurable sets, Regularity, Measurable functions, Borel and Lebesgue measurability, Non-measurable sets, Integration of Non-negative functions, The General integral, Integration of series.

Measure and outer measures, Extension of a measure , Uniqueness of Extention, Completion of a measure, Measure spaces, Integration with respect to a measure, Riemann and Lebesgue integrals.

The four derivatives, Lebesgue Differentiation theorem, Differentiation and Integration.

Functions of Bounded variation, L^P- space, convex functions, Jensen's inequality, Holder and Minkowski inequalities, completeness of L^P- space, convergence in measure, almost uniform convergence.

References:

1. R.R. Goldberg, Methods of Real Analysis.
2. W. Rudin, Principles of Mathematical Analysis.
3. R.G. Bartle, The Elements of Real Analysis (only for Fourier Series), 2nd Ed., J .Wiley, NY, London.
4. Kenneth A. Ross, Elements of Analysis: The Theory of Calculus, Springer Verlag, UTM, 1980.

MSC 1.3: Topology-I

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Topological spaces, basis, subbasis, product topology (for finite case), quotient topology, subspace topology, closure, interior.

Continuous functions and their characeterization, countability Axioms, Separation Axioms, Hausdorff topological spaces, Regular topological spaces, Normal topological spaces.

Connected topological spaces, Path-connected topological spaces, continuity and connectedness, local connectedness, Connected components of a topological space, Path components of a topological space.

Compact spaces, limit point compact spaces, continuity and compactness, Tube lemma, compactness and product topology, local compactness, one point compactification.

Complete metric spaces, Completion of a metric space, Total boundedness, compactness in Metric spaces, sequentially compact metric spaces, uniform continuity, Lebesgue covering lemma.

Recommended Books

1. James Munkres: Topology, Pearson.
2. George Simmons: Topology and Modern Analysis, Tata Mcgraw-Hill.
3. M. A. Armstrong: Basic Topology, Springer UTM.
4. J. L. Kelley, General Topology, Van Nostrand, Reinhold Co. New York, 1995.
5. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Pvt. Ltd.

6. K. D. Joshi, introduction to General topology, New Age International Pvt. Ltd. Publ., New Delhi(2006).

MSC 1.4: Differential Geometry-I

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Curves in space R^3: Arc length, tangent, osculating plane, normal plane, principal normal and binormal, curvature and torsion, Serret-Frenet formulae, Frenet's approximation, oscillating circle, osculating sphere, spherical indicatrices, involutes & evolutes, helix, intrinsic equation of a curve.

Surface in R^3: Surfaces, surfaces of revolution, helicoids, families of curves on a surface, the first and second fundamental forms of a surface, principal directions, lines of curvature, principal curvatures, and Gaussian curvature, Dupin indicatrix, normal curvature.

Books:

1. T. J. Willmore: An Introduction to Differential Geometry.
2. L. P. Eisenhart: An Introduction to Differential Geometry.
3. M. Spivak: A Comprehensive Introduction to Differential Geometry.

MSC 1.5: Discrete Mathematical Structures

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Formal logic: Statements and logical connectives (negation conjunction disjunction) and formulas. Truth tables conditional and bi-conditional statements, well-formed formulas, tautologies and contradiction, equivalent formulas, duality law, functionally complete set of connectives, two state devices and logic gates, normal forms, principle conjunctive and principle disjunctive normal forms. The theory of inference for the statement calculus, rules of inference, automatic theorem proving method, the predicate calculus: predicate, quantifiers, , free and bound variables, inference theory of the predicate calculus.

Semigroup and Monoid: Semi groups and monoids, concatenation operation, Homomorphism of semi groups and monoids, congruence relations and quotient semi groups, sub semi groups and sub monoids. Direct products. Basic homomorphism theorem.

Lattices: Lattices as partially ordered sets, their properties, lattices as algebraic

systems, sub lattices, directs products and homomorphism, complete, complimented and distributive lattices.

Boolean Algebra: Boolean algebra as lattices, various Boolean identities , The switching algebra, sub-algebra, direct products, homomorphism, join irreducible elements and min-terms, Boolean forms and their equivalences, min-term Boolean forms, sum-of-products and products-of-sum canonical forms, minimization of Boolean functions, application of Boolean algebra to switching theory (using AND, OR and NOT Gates), Karnaugh map.

Text Books:

1. J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Mc-Graw Hill Book Company, 1977.
2. C. L. Liu, Elements of Discrete Mathematics, Mc-Graw Hill Book Company.

Reference Books:

1. S. Witala, Discrete Mathematics: A Unified Approach, Mc-Graw Hill Book Company.
2. S. Lepschutz, Finite Mathematics, Mc-Graw Hill Book Company.

MSC 2.1: Algebra - II

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Algebra of Linear transformations, Characteristics roots and matrices for linear transformations, Canonical Forms - Similarity of Linear transformations invariant subspaces, Reduction to triangular form, Nilpotent transformation, Index of Nilpotency, Invariants of a nilpotent transformation, the primary decomposition theorem. Jordan blocks and Jordan forms.

Noetherian and Artinian Modules and rings, Hilbert's Basis theorem, Wedderburn Artin Theorem, Smith Normal form over a PID and Rank.

Fundamental structure theorem for finitely generated modules over a principal Ideal Domain and its applications to finitely generated abelian groups. Rational canonical form, Generalized Jordan form over any field.

Text Books:

1. P.R. Bhattacharya, S.K. Jain and S.R.Nagapaul Basic Abstract Algebra IInd Edition cambridge University press Indian Edition 1997.
2. I.N.Herstein Topics in Algebra, Wiley Eastern Ltd. New Delhi 1975.

Reference Books:

1. M.Artin Algebra, Prentice Hall of India 1991.
2. D.S.Malik, J.N. Mordeson & M.K. Sen, Fundamentals of Abstract Algebra Mc-Graw Hill International Edition.

MSC 2.2: Complex Analysis

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Conformable transformations and Bilinear transformations, Harmonic conjugates, transformations of Harmonic functions, Transformations of Boundary conditions, stedy temperatures, steady temperature in a Half plane, temperatures in a quadrant, electrostatic potential, potential in a cylinderical space, two-dimensinal fluid flow, the stream function, flows around a corner and around a cylinder.

Line integrals, primitive, Cauchy's Theorem for a disc, Cauchy's theorem and applications, Cauchy's estimate, Cauchy integral formula, Entire functions, Louville's theorem, Morera's theorem.

Complex power series, Taylor's series, Sequences and series of functions, Uniform convergence, Power series, radius of convergence of a power series.

Singularities, Isolated singularities, poles and essential singularities, Laurent Series, removable singularities, Riemann's theorem, Casorati-Weirstrass theorem, Argument principle, Rouche's theorem.

Holomorphic functions and their properties, Maximum modulus theorem, zeros of analytic functions, analytic continuation.

Cauchy's Residue Theorem and its applications, evaluation of standard types of integrals by the residue calculus method.

References:

1. James W. Brown & Ruel V. Churchill: Complex variables and applications, Mcgraw-Hill Asia. Churchill, Brown, Complex Analysis - Ed. V
2. J. B. Conway, Functions of One Complex Variable.
3. Serge Lang: Complex Analysis, Springer.
4. R. Remmert: Theory of complex functions, Springer.

MSC 2.3: Topology-II

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Product topology: Tychonoff product topology (arbitrary case) and its characterizations, Tychonoff theorem .

Projection maps. Connectedness and product spaces. Compactness and product spaces (Tychonoff's theorem) Urisohn's Lemma. Stone Catch Compactification.

Homotopy, Path homotopy, The fundamental group, Simply connected spaces, Covering spaces, Path lifting and homotopy lifting lemma, Fundamental group of the circle. Deformation retracts and homotopy types, Fundamental group of S_n; Fundamental group of the projective space, Brower fixed point theorem, Fundamental theorem of algebra, Borsuk-Ulam theorem.

Text Book:

1. James R. Munkres, Topology, A First Course in Topology, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
2. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

Reference Books:

1. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Pvt. Ltd.)
2. J. L. Kelley, General Topology, Van Nostrand, Reinhold Co. New York, 1995.
3. S. Willard, General Topology, Addition-Wesley, Regarding, 1970.

MSC 2.4: Differential Geometry -II

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Surface in R^3: Conjugate curves, asymptotic lines, developablesurface, minimal surfaces, ruled surfaces, Christoffel symbols, Gauss-Weingarten formulae, Gauss equations, Codazzi-Mainardi equations, the Riemannian curvature tensor, geodesics on surface of revolution, geodesic curvature of a curve.

Tensors and differential forms: Tensor product of vector spaces, tensor fields, differential forms, exterior derivative, orientation of manifolds, covariant differentiation, identities satisfied by forms, exterior derivation, identities satisfied by curvature and torsion tensors, the Koszul connexion.

Books:

1. T. J. Willmore: An Introduction to Differential Geometry, Oxford University Press, New York, 1959.
2. L. P. Eiscehart: An Introduction to Differential Geometry, Princeton University Press, Princeton, New Jersey,1940.
3. M. Spivak: A compressive Introduction to Differential Geometry.
4. T. J. Willmore: Riemannian Geometry, Oxford University Press, USA.

MSC 2.5: Graph Theory

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Definition of undirected graphs, Four colour theorem, paths, circuits, cycles and subgraphs. Induced subgraphs degree of a vertex, connectivity. Planar graphs and their properties, tree, Euler's formula for connected planer graphs, complete and complete biparted graphs. Kuratowaski's theorem (Statement only) and its use.

Spanning trees, cut sets, fundamental cut sets and cycles. Minimal spanning trees. Matrix representation of graphs. Euler's Theorem on the existence of Eulirian path and circuits. Directed graphs, in degree and out degree of the vertex, weighted undirected graphs, Shortest path problems.

Finite state machine and their transition table diagrams, equivalence of finite state machine, reduced machines

Text Books:

1. J. P. Trembly and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Mc-Graw Hill Book Company, 1977.
2. J. L. Gersting, Mathematical structures for Computer Science, III- Edition, Computer Sci. Press New York.
3. C. L. Liu, Elements of Discrete Mathematics, Mc-Graw Hill Book Company.
4. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India.

Reference Book:

1. S. Lepschutz, Finite Mathematics, Mc-Graw Hill Book Company.

MSC 3.1: Functional Analysis

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Normed linear spaces, properties of normed spaces, subspaces, Banach spaces, compactness and finite dimensional spaces, linear operators, bounded and continuous linear operators, linear functional, linear operators and functional on finite dimensional spaces, normed spaces of operators, dual spaces.

Hahn-Banach theorem, complex normed linear spaces, applications to bounded linear functionals on C[a,b], adjoint operators, reflexive spaces, Category theorem, Uniform boundedness theorem and some of its consequences, strong and weak convergence, convergence of a sequence of operators and functionals, Open mapping theorem and closed graph theorem.

Banach fixed point theorem and its applications to linear equations, differential equations and integral equations.

Text Books:

1. Ervin Kreyszig, Functional Analysis, Willy Eastern Publications.
2. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

MSC 3.2: Theory of Differential Equations –I

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Linear differential equations of order two or more: Higher order linear differential equations, a modelling problem, Linear independence, equations with constant coefficients, equations with variable coefficients, Wronskian, method of variation of parameters, method of Laplace transform.

Power Series Solution: Second order linear equations with ordinary points, Legendre equations and Legendre Polynomials, Second order equations with regular singular points, Bessel's equations and Bessel's functions.

Systems of Linear Differential Equations : Systems of First order equations, some examples, Existence and uniqueness theorem, Fundamental matrix, Non-homogeneous linear systems, Linear systems with constant coefficients, Linear systems with periodic coefficients.

Existence and Uniqueness of Solutions: Successive approximations, Picard's iteration method with some examples, Continuation of solution of IVP and dependence on initial conditions, Existence and uniqueness of solutions of systems, Fixed point method.

Text book:

1. S.G. Deo, V. Lakshmikantham and V. Raghavendra: Text book of Ordinary Differential Equations, Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.

Recommended Books:

1. George F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. W.T. Reid, Ordinary Differential Equations, John Wiley & Son's, NY (1971)
3. Phillip Hartman, Ordinary Differential Equations, John Wilwy& Son's, NY(1971)
4. E.A. Coddington and N. Levinson, Theorem of Ordinary Differential Equations, Mac, Graw Hill, Ny(1955)

MSO 3.1: Fuzzy Sets, Fuzzy Logic and their Applications –I

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Fuzzy Sets: Basic definitions, α-cuts, convex fuzzy sets, Basic operations on fuzzy sets, Types of fuzzy sets, Properties of α-cuts, Representation of fuzzy sets, First and second decomposition theorems, Extension principle for fuzzy sets, fuzzy complements, The characterization theorems for fuzzy complements, T-norms and T-conorms, Algebraic product and sum, bounded difference and sum, Statements of characterization theorem for T-norm and T-conorm, combination of operations.

Fuzzy Arithmetic: Fuzzy numbers, Arithmetic operations on fuzzy numbers, Lattices of fuzzy numbers, fuzzy equations.

Fuzzy Relations: Fuzzy relation on a set, Fuzzy binary relation and fuzzy equivalence relations, Fuzzy morphism, Standard composition of fuzzy relation, sup-i composition, Inf-ω_i composition of fuzzy relations.

Text Book:

1. G. J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic. Theory and Applications, Prentice-Hall of India Pvt. Ltd., New Delhi 2002.

Reference Book:

1. H. I. Zimmerman, Fuzzy Set Theory and its Applications, Allied publishers Ltd., New Delhi, 1991.

MSO 3.2: Integral Equations

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Basic concept of Integral Equations, Classification of integral equations, Libnitz's rule of differentiation under the sign of integration, transformation of differential equation into integral equation and vice-versa.

Volterra Integral Equations: Resolvent Kernel, Method of successive approximation.

Fredholm Integral Equations: Method of successive approximation, Orthogonal Kernels, Iterated kernels, Fredholm determinants, Degenerated kernels, Eigen value and Eigen function of homogeneous integral equations.

Boundary Value Problem, Green's function.

References:

1. Abdul-Majid Wazwaz, A first course in Integral Equations, World Scientific Publishing Co. Pvt. Ltd.
2. M. Rahman, Integral Equations and their Applications, WIT*PRESS*, Boston.
3. A.D. Polyanin and A.V. Manzhirov, Handbook of Integral Equations, CRC Press, Boca Raton/London/New York/Washington D.C.
4. Ram P. Kanwal, Linear Integral Equations, Theory and technique, Academic Press, New York/London.
5. A.B. Chandramouli, Integral Equations with Boundary Value Problems, Shiksha Sahitya Prakashan.

MSO 3.3: Operations Research-I

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Operations research (O.R.): Origin and development, Nature and future, scientific methods, Modelling in O.R., advantages and limitations of models, general solution methods for O.R. models, methodology of O.R., O.R. and decision making, applications of O.R.

Inventory control: Types inventories, reasons for carrying inventories, the inventory decisions, objectives of scientific inventory control, costs associated with inventories, factors affecting inventory control, an inventory control problem, the concept of EOQ, Deterministic inventory problems with no shortages, Deterministic Inventory problem with shortages, problems of EOQ with price breaks, multi-item deterministic problems, dynamic order quantity, selective inventory control techniques .

Inventory problems with uncertain demand, systems of inventory control, one period problem, one period problem without set-up cost, one period problem with set-up cost, dynamic programming and inventory control.

Queuing theory: Queuing system, elements of a Queuing system, operating characteristics of a Queuing system, deterministic Queuing system, probability distributions in Queuing system, classification of Queuing models, definition of transient and steady states, Poisson Queuing systems, non-Poisson Queuing systems, cost models in Queuing , other Queuing models.

Replacement Problem

Text Books:

1. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
2. G. Hadley, Nonlinear and Dynamic Programming, Addison –Wesley, Reading Mass.
3. H. A. Taha, Operation Research- An Introduction, Macmillan Publishing Co. Inc., New York.
4. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.

5. P. K. Gupta and D. S. Hira, Operations Research- An Introduction, S. Chand & Company Ltd. New Delhi.

6. J.K. Sharma

Reference Book:

1. S. D. Sharma, Operation Research, S. Chand Publ. , New Delhi.

MSO 3.4: Differential Geometry of Manifolds

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Differentiable manifolds: Smooth maps, charts, atlas, differentiable structure, Definition and examples of differentiable manifolds, Tangent spaces, Vector fields on differentiable manifolds, Vector fields and Lie bracket.

Integral curves and Flows: Definition and One parameter group of transformations.

Exterior Algebra, Exterior derivative: Definition, examples and related problems.

Linear Connection: Affine connections, Torsion tensor of affine connection, Curvature tensor of affine connection and related problems.

Riemannian Manifolds: Definition, Riemannian connection, Riemannian metric, Sectional curvature tensor, Schur's theorem, Projective curvature tensor, conformal curvature tensor, Semi- symmetric metric connection and related theorems.

Books:

2. R. S. Mishra: A course in Tensor with applications to Riemannian Geometry, Pothishala (Pvt.) Ltd, Allahabad, 1965.

3. Y. Matsushita: Differentiable manifolds, Marcei Dekkar, 1972.

4. B. B. Sinha: an Introduction to modern differential geometry, Kalyani Prakashan, New Delhi, 1982

MSO 3.5: Difference Equation- I

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Difference Calculus- The Difference Operator, Summation, Generating functions and approximate summation.

Linear Difference Equations- First order equations. General result for linear equations. Equation with Constant coefficients. Applications. Equations with variable coefficients. Nonlinear equations that can be linearized. The z-transform.

Stability Theory- Initial value problems for linear systems. Stability of linear systems.

Stability of nonlinear systems, Chaotic behaviour.

Asymptotic methods- Introduction. Asymptotic Analysis of sums. Linear equations. Nonlinear equations.

Text Book:

W. G. Kelley and Allan C. Peterson- Difference Equations. An Introduction with Applications. Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.

References:

C. Ahlbrandt and A. C. Peterson. Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations. Kluwer, Boston, 1996.

MSO 3.6: Information Theory and its Applications

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Basic concepts of information theory: Memory less finite schemes. Elements of encoding.

Discrete schemes without memory: Basic concepts of discrete Probability.

Continuous channel without memory. Entropy of a single events. Functional Equations. Shannon's measure of informations. The fundamental equation of informations. Applications of informations theory in various fields.

Books Recommended:

1. F.M. Reza, An introduction to information theory, Dover Publications Inc. New York
2. J. Aczel and Z. Doroczy, On Measures of information and their characterizations, Academic Press, New Yark.
3. Robert B. Ash, Information Theory, Interscience Publisher, New York
4. John R. Pierce, An Introduction to Information Theory, Dower Publications Inc. New York
5. John Avery , Information theory and evolution, World Scientific , New Jersey

MSO 3.7: Object Oriented Programming with C++

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Principles of Object Oriented Programming: A look at procedure-oriented programming, Object oriented programming Paradigm, Basic Concepts of Object Oriented Programming, Benefits of OOP, Object oriented languages, Applications of OOP, Concept of C++, Applications of C++ , Structure of C++ program, creating the

source files, Compiling and linking a simple C++ program.

Tokens Expressions and Control Structure: Tokens, Keywords, Identifiers and constants, basic data types, User defined data types, Storage classes, Derived data types, Symbolic constants, Type compatibility, Declaration of variables, Dynamic initialization of variables, Reference variables.

Operators and Expressions: Operators in C++, Scope resolution, Operator, Member differencing Operators, Memory Management Operators, Manipulators, Type cast operators, Expressions and their types, Special assignment expressions, Implicit conversion operator, overloading, Operator precedence, Control structure.

Functions in C++: The main functions, Function Prototypes, Call by reference, Returned by reference, Inline function, Default argument, Constant argument, Recursion, Function overloading, Friend and Virtual function, Math library functions.

Classes and Objects: C structures revisited, Specifying a class, Defining member function in a C++ program with class, Nesting of member functions, private member function, Arrays within class, Memory allocation for objects, Static data members and static member functions, Arrays of objects as a function arguments, friendly function, returning objects, Constant member functions, Pointers to members, local classes.

Constructors and Destructors: Constructors, parameterized constructors, multiple constructors in a class, Constructors with default arguments, Dynamic initialization of objects, Copy Constructor, Dynamic Constructor, Destructors.

Inheritance: Defining derived classes, single inheritance, Multi level inheritance, multiple inheritance, Hierarchical inheritance, Hybrid Inheritance.

Pointers and Virtual Functions: Pointers, Pointers to objects this Pointers, Pointers to derived classes, Virtual functions, Pure virtual function, Virtual constructors and destructors.

Working with Files: Classes for files stream operations, Opening and closing a file ,Detecting a file, File Modes, File pointers and their manipulation, sequential input and output operations, Random Access, Error handling during file operations.

Text Books:

1. E. Balagurusmy, Object oriented programming with C++, Tata Mac-Graw Hill.

Reference Books:

1. D. Ravichandan, Programming with C++
2. M. P. BhaveS. A. Patekar, Object Oriented Programming With C++ Pearson Education
3. Robert Lafore Object Oriented Programming in turbo C++ Pearson.

11/7/18

MSO 3.8: Number Theory and Cryptography

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Elementary Number Theory : Divisibility and Euclidean Algorithm, Congruence, Applications to factoring, Time Estimates for doing arithmetic.

Cryptography : Some simple crypto systems, Enciphering matrices.

Finite Fields and quadratic Residues, Quadratic residues and Reciprocity.

Public Key Cryptography: The idea of public key cryptography, RSA, Discrete log, Knapsack.

Primality and Factoring: Pseudo primes, The rho method, Fermat factorization and factor bases, The Continued fraction method, The quadratic sieve method.

Recommended Text

1. Neal Koblitz, A Course in Number Theory and Cryptography, Springer-Verlag, NewYork, 2002, Second Edition.

Reference Books

1. Niven and Zuckermann, An Introduction to Theory of Numbers (Edn. 3), WileyEastern Ltd., New Delhi, 1976.
2. David M.Burton, Elementary Number Theory, Wm C.Brown Publishers, Dubuque,Iowa, 1989.
3. K.Ireland and M.Rosen, A Classical Introduction to Modern Number Theory, Springer Verlag, 1972.
4. J. Buchmann, Introduction to Cryptography, Second Edition (2005), Springer.

MSC 4.1: Advanced Functional Analysis

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Inner product spaces. Hilbert spaces. Orthonormal sets. Bessels inequality. Structure of Hilbert spaces. Projection theorem. Adjoint of an operator on a Hilbert space. Reflexivity of Hilbert spaces. Self adjoint operator, positive projection, normal and unitary operators.

Convex Sets and Projections, Orthogonality and Orthonormal Bases, Continuous Linear Functionals, Riesz Representation Theorem, Weak Convergence, Nonlinear Functionals and Generalized Curves, The Hahn-Banach Theorem.

Support functional of a Convex Set, Minkowski Functinoals, The Support Mapping Theorem, Separation Theorem, Applications to Convex Programming, Geeralization to

Infinite Dimensional Inequality, The Fundamental Result of Game Theory: Minimax Theorem, Application: Theorem of Farkas.

Text Book:

1. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
2. Alampallam V. Balakrishnan, Applied Functional Analysis (Applications of Mathematics), Springer, 2nd edition (May 4, 1981), ISBN-10: 0387905278.

MSC 4.2: Theory of Differential Equations –II

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Boundary value problems: Sturm-Liouville Problem, Green's function, Application of Boundary Value Problem, Picard's theorem.

Oscillations of second order equations: Fundamental results, Sturm's Comparison theorem, Elementary linear oscillations, Comparison theorem of Hille , Wintner, oscillations of $x'' + a(t)x = 0$.

Stability of linear and nonlinear systems: Elementary critical points, system of equations with constant coefficients, Linear equation with constant coefficients, Lyapunov stability, stability of quasi linear systems, second order linear differential equations,

Equations with deviating arguments: equations with constant delay, Equations with piecewise constant delay, a few other types of delay equations.

Text Book: S.G. Deo, V. Lakshmikantham and V. Raghavendra: Text book of ordinary Differential equations, Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.

Recommended Books:

1. George F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. W.T.Reid, Ordinary Differential Equations, John Wiley &Son's, NY (1971)
3. Phillip Hartman, Ordinary Differential Equations, John Willy &Son,s, NY(1971)
4. E.A. Coddington& N. Levinson, Theorem of Ordinary Differential Equations, Mac, Graw Hill, Ny(1955)

MSO 4.1: Fuzzy Sets, Fuzzy Logic and their Applications –II

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Fuzzy Relation Equations: General discussion, problem partitioning, Solution method, Fuzzy relation equation based upon sup-*i* composition and inf ω_i composition, approximate solutions.

Possibility Theory: Fuzzy Measures, Evidence theory, Possibility theory, Fuzzy sets and possibility theory, possibility theory versus probability theory.

Fuzzy Logic: An overview of classical logic, Multivalued logic, Fuzzy propositions, Fuzzy quantifiers, Linguistic Hedges, Inference from conditional, conditional and qualified propositions, quantified propositions.

Approximate Reasoning: An overview of fuzzy expert systems, fuzzy implications and their selection, Multi conditional approximate reasoning, Role of fuzzy relation equations.

Fuzzy Systems: An introduction to fuzzy controllers, fuzzy rule base, fuzzy inference engine, Defuzzification and the various defuzzification methods (the centre of area method, centre of maxima method, mean of maxima method)

Fuzzy Decision Making: General discussion, Individual decision making, multi-person decision making, multi-criterion decision making, multi-stage decision making, fuzzy ranking methods, fuzzy linear programming.

Text Book:

G. J. Klir and B. Yuan, Fuzzy sets and fuzzy logic. Theory and Applications, Prentice- hall of India pvt. Ltd., New Delhi 2002.

Reference Book:

H. I. Zimmerman, Fuzzy set theory and its application, Allied publishers Ltd., New Delhi, 1991.

MSO 4.2: Finsler Geometry

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Basic Concepts of a Finsler space: Line elements, Finsler space, Minkowskian space, Tangent space, Metric Tensor, Dual tangent space, Hamiltonian function, Angle between two vectors, Generalized Christoffel symbols, Geodesics.

Covariant Differentiation: δ-derivative, Partial δ-derivative, Fundamental postulates of E. Cartan, Different deductions, Cartan's two processes of covariant differentiation, Berwald connection parameters, Berwald's covariant differentiation.

Theory of Curvature: Commutation formulae resulting from Cartan's covariant differentiation, Cartan curvature tensor, Commutation formulae resulting from Berwald's covariant differentiation, Berwald curvature tensor, Generalizations of Bianchi identities, Space of scalar curvature, Space of constant curvature, Generalization of Schur's theorem, Recurrent spaces, Symmetric spaces.

Projective Change: Projective change, Projective invariants, Projective change of Berwald's connection parameters, Projective deviation tensor, Generalized Weyl's projective curvature tensor.

Projective connection parameters, Projectively flat spaces, Szabó Theorem.

Lie derivatives and their applications: Infinitesimal transformations, Lie derivative of scalars, vectors and tensors, Lie derivative of connection parameters of Cartan and Berwald, Motion, Affine motion and Projective motion.

Books Recommended:

1. H. Rund, The Differential Geometry of Finsler Spaces, Springer-Verlag, Berlin, 1959.
2. M. Matsumoto, Foundations of Finsler Geometry and Special Finsler Spaces, Kaisheisha Press, Otsu, 1986.
3. P.L. Antonelli (ed.), Handbook of Finsler Geometry, Kluwer Academic Publishers, Dordrecht, The Netherlands, 2003.

MSO 4.3: Operations Research-II

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Sequencing problem: introduction, problems of sequencing, the basic terms of use in sequencing, processing n –jobs through two machines, processing n-jobs through k-machines, processing two jobs through k-machines,

Dynamic programming problem: introduction, the recursive equation approach, charactersitcs of dynamic programming, dynamic programming algorithm, solution of DPP, some applications, solution of LPP by dynamic programming.

Integer Programming: Introduction, Pure and mixed integer problems, Gomory's All I.P.P method, construction of Gomory's constants, fractional cut method All I.P.P. , fraction cut method -mixed integer linear programming problem, Branch and bound method, applications of integer programming.

Non-Linear Programming: Introduction, formulating a Non-linear programming problem(NLPP), general NLPP, constraint optimization with equality constraints, constraint optimization with inequality constraints,saddle point problems, saddle point and NLPP.

Text Book:

1. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.
2. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
3. G. Hadley, Nonlinear and Dynamic Programming, Addison –Wesley, Reading Mass.
4. H. A. Taha, Operation Research- An Introduction, Macmillan Publishing Co. Inc., New York.
5. Prem Kumar Gpta and D. S. Hira, Operations Research- An Introduction, S. Chand & Company Ltd. New Delhi.

Reference Book:

1. S. D. Sharma, Operation Research, S. Chand Publication, New Delhi.

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MSO 4.4: Complex Manifolds

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Complex Manifold and Almost complex manifold: Definition and examples, Nijenhuis tensor, Eigen Values of an almost complex structure, Existence theorem and integrability condition, contravariant and covariant almost analytic vector fields.

Almost Hermite manifold: Nijenhuis tensor, Almost analytic vector fields, Curvature in almost Hermite manifold, Holomorphic Sectional Curvature, Linear connection in an almost Hermite manifold

Kaehler Manifolds: Holomorphic Sectional Curvature, Bochner Curvature tensor, Affine connection in almost Kaehler manifold.

Nearly Kaehler Manifolds: Definition, Projective correspondence between two Nearly Kaehler manifolds, Curvature identities.

Para Kaehler Manifolds: Definition, Curvature Identities and conformal flatness of parakaehler manifold.

Books:

1. R. S. Mishra: A course in Tensor with applications to Riemannian geometry, Pothishala (Pvt.) Ltd, Allahabad.
2. B. B. Sinha: an Introduction to modern differential geometry, Kalyani Prakashan, New Delhi, 1982.
3. K. Yano: Structure of Manifolds, World Scientific Publishing Co. Pvt. Ltd., 1984.

MSO 4.5: Difference Equations- II

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

The self-adjoint second order linear equation, Sturmian theory, Green's functions, Disconjugacy, The Riccati Equations, Oscillation.

The Srurm-Liouville problem-Introduction, Finite Fourier Analysis, A non-homogeneous problem.

Discrete Calculus of variations, Necessary conditions, Sufficient Conditions and Disconjugacy.

Boundary Value Problems for Nonlinear equations, The Lipschitz case, Existence of solutions, Boundary value Problems for Differential equations.

Partial Differential Equations, Discretization of Partial Differential Equations, Solutions of Partial Differential Equations.

Text Book:

W.G. Kelley and Allan C. Peterson- Difference Equations. An Introduction with Applications. Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.

References:

C. Ahlbrandt and A. C. Peterson. Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations. Kluwer, Boston, 1996.

MSO 4.6: Financial Mathematics and its Applications

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Financial Derivatives – An introduction: Types of financial derivatives –Forwards and futures: Options and its kinds and SWATS. Securities markets, Technical Analysis and fundamental analysis.

The arbitrage theorems and introduction to portfolio selection and capital market theory; Static and continuous-time models.

Pricing by arbitrage- A single period option pricing model; Multi period pricing models- Cox-Ross-Rubinstein Model.

Martingales and martingales representation, the Black –Scholes option pricing model-using no arbitrage approach, limiting case of binomial option pricing and risk –neutral probabilities.

The American option pricing –extended trading strategies; analysis of American of put and call option.

Books Recommended

1. John C Hall, Options , features and other derivatives, Prentice- Hall of India Private Limited.
2. Sheldon M Ross, An introduction to Mathematical Finance, Cambridge University Press.
3. Sahil N. Nettci and Ali Hirsa, An introduction to Mathematics of financial derivatives, Academic Press Inc.
4. Robert J Elliot and P. ekkehard Kopp, Mathematics of financial markets, Springer-verlag New Yark Inc.
5. Kevin, Security analysis and portfolio management, PHI learning Private limited

MSO 4.7: PROJECT

Note: Under the guidance of faculty member(s) on a topic to be approved by the Department.

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